UNITED NATIONS

GENERAL
ASSEMBLY

Distr.
GENERAL

A/CONF.100/PC/38
6 March 1981

ORIGINAL: ENGLISH

PREPARATORY COMMITTEE FOR THE
UNITED NATIONS CONFERENCE ON NEW
AND RENEWABLE SOURCES OF ENERGY
Third session
30 March-17 April 1981
Item 2 of the provisional agenda*

SUBSTANTIVE PREPARATIONS FOR THE CONFERENCE

Report of the Ad Hoc Expert Group on Rural Energy, including the Utilization of Energy in Agriculture

* A/35/43 (Part II) and Corr.1, para. 67.

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I. INTRODUCTION

1. By resolution 33/148 of 20 December 1979, the General Assembly decided to convene a United Nations Conference on New and Renewable Sources of Energy at Nairobi, in August 1981, with the objective of promoting the development and utilization of new and renewable sources of energy to help meet future over-all energy requirements. The decision to convene the Conference was a recognition of the crucial role that energy plays in the over-all development of all countries and the importance of additional supplies of energy to meet the requirements for continued economic development over the next decades.

2. As part of the preparatory process for the Conference, the Ad Hoc Expert Group on Rural Energy, including the Utilization of Energy in Agriculture, comprising persons appointed by the Secretary-General of the United Nations Conference on New and Renewable Sources of Energy, met at Nairobi from 26 to 30 January 1981. Its function was to examine issues relating to the supply and utilization of energy in rural areas, with special emphasis on new and renewable sources of energy, and to suggest ways to promote more widespread use of new energy technologies and systems in the rural areas.

II. THE SITUATION AND PROSPECTS OF RURAL ENERGY

3. A critical situation has been building slowly in the rural sector of the developing countries over many years, long predating the 1973 "oil crisis" and its aftermath. The energy crisis in the rural sector, which affects about 2 billion people directly, is centred around the uses of fuelwood and crop and animal residue, which provide the bulk of the energy used by those who live in the rural areas, small towns and villages of the developing world. It is sometimes referred to as "the second energy crisis" and is intimately connected with and in fact exacerbated by the "oil crisis". Its resolution is tied to that of oil.

4. The poverty of the rural sector is a reflection (and a consequence) of its heavy dependence on such "low quality" sources of energy as wood and muscle power. The developing countries with the lowest living standards are distinguished by their low level of energy use per capita and the inefficient use of these "low quality" energy sources. Notwithstanding the fact that as much as 95 per cent of energy in the rural area comes from these low quality sources, the energy requirements of the rural sector account for only about one fifth of the total consumption of the developing countries. In these areas, the energy is used predominantly for cooking and heating. Poverty prevails because of the low capability for harnessing the interest of the "energy slaves" in high-quality energy and its concomitant technology. This incapacity to utilize energy is well rooted, making escape from "the poverty trap" very difficult to achieve. When four fifths of the energy consumption is in the "modern sector" and this creates heavy dependence on oil imports, the problem is compounded.

5. In focusing on this rural poverty-energy relationship, the whole picture must be kept in mind, but the spotlight on the rural aspect serves to illuminate

more clearly the nature and scope of "the second energy crisis", which has been brought about by the rural populace's heavy dependence on fuelwood and crop and animal residue for meeting the basic need to fuel stoves and heat houses. Those in the rural sector have little or no access to fuels other than those that are close at hand and "free" - namely, fuelwood, agricultural and animal residues and human wastes. The crisis manifests itself in the vicious circle brought on by the depletion of forest cover and burning of soil nutrients which lead to loss of topsoil, lower agricultural productivity, lower incomes and greater dependence on "free" fuelwood and residue.

6. The developing countries have been consuming their wood supplies much faster than they can be renewed. The energy nature of this trend is already evident in many countries, with environmental, economic and social consequences that are dramatically clear. In others, the dynamics of this deterioration process are widely perceived, but it is seen as a medium-team problem. Few policy-makers have shown that they recognize how difficult it will be with each passing month to slow down, stop and reverse the situation. On a global basis, forest-cover is decreasing at an alarming rate, with potentially dire ecological, climatic consequences for the planet. The estimated net loss is as high as 15 million hectares a year, with serious additional losses measured in worsening soil conditions and water supply. The use of animal manure as fuel deprives the soil of nutrients, which is estimated to "cost" annually 20 million tons of foregone grain production. In some areas, the "cost" is evident in accelerating desertification. The social cost of the reduction in the productivity of the land is high. As the agricultural sector weakens, with growing under-employment and unemployment, the rate of migration to urban centres accelerates to further aggravate an already critical condition there.

7. The direct and immediate impact on the rural poor must be counted in the "costs" of this process, but account must also be taken of the less direct impact on the urban poor who have been forced to leave the rural areas. Beyond that, the cost must be measured by the increased strain on the developing countries which are striving to diversify and grow, and which find their agricultural sector a drain rather than a source of "surplus" to sustain the process of industrialization and all that goes with development. Taking the broader perspective, it is a global problem which calls for a global response in the sense of joint action by many nations.

8. It would be too narrow a view to see this as a problem related to the effect on the rural populace of the severe fuelwood shortage. It takes a heavy toll on their strength and will, apart from its economic costs. It is relatively easy to understand this in terms of time spent to gather fuelwood and cash spent to buy fuelwood. Villagers, mainly women and children, who could previously collect fuelwood in the vicinity of their homes, now find that they must search for it for half a day or more. For example, families in the upland areas of Nepal are spending the equivalent of 230 person-days per year on fuelwood collection, while in some parts of the United Republic of Tanzania 250 to 300 work days are required to meet family needs. Nor is the impact limited to rural areas A recent World Bank survey found poor families in the Bujumbura, the capital of Burundi, to be spending upwards of 30 per cent of their income for fuel, mainly charcoal. It is no less important to recognize the cost in terms of how this vicious circle affects the long-term prospects for alleviating such poverty.

9. The development of alternative energy sources will have its most important impact in helping developing countries meet this "second energy crisis". Its impact should be measured not only by the quantity of energy produced but also by the contribution made to welfare and development. Small hydrosystems, wood burning power plants, wind pumps and other renewable sources of mechanical and/or electrical power, while perhaps not adding significantly to national energy supplies can, as a first payoff, improve the lives of large numbers of the poorest people by providing power for agriculture and rural industries.

A. The complexity of rural energy systems

10. Rural energy use takes place in the context of complex, interrelated physical, economic and social systems. Energy flows exhibit many interconnexions. Most traditional fuel resources serve many purposes. Leaves and twigs may serve as animal fodder or firewood; the trees themselves may be harvested for fuelwood or building materials; residues from the trees may be spread or used as fertilizer. Crop and animal residues also have competing uses: new straw for animal feed, compost, fuel or soil nutritioner; and dung for fertilizer, fuel or feedstock. There is often a delicate resource balance within a household or village that limits resource availabilities for fuel. Any resource adjustments - for example, fire, livestock, forest clearing for agriculture, or higher crop yields - imply altered energy availabilities and needs. Consequently, for many energy resources, infrastructure planning must account for these complex competing uses of the food, fuel, fodder and fertilizer.

11. A number of economic and social factors contribute to the complexity of these systems. Many traditional fuels do not enter cash markets; charcoal and fuelwood for urban consumers are the exceptions. There are frequently complex service or exchange relations involved and the role of women is primary in these activities. Residue and fuelwood availability to the user can vary from country to country, within a country and among groups within a specific village.

12. There are various reasons for this: policies may constrain availability - for example, a regulation to burn crop residues in the field to control diseases; access to fuelwood and forest, crop and animal residue may be closed to the poor who do not own or have access to the producing resources; forest depletion may be very serious locally while fuelwood may be plentiful some distance away. The class access issues are very important and often overlooked. In many situations where patron-client relationships are replaced by impersonal market transactions, the poor face the brutal reality of food and fuel scarcity. Another complicating factor in rural energy system are inefficiencies in use, e.g. low efficiency of village stoves, kilns and the like and the insufficiency of energy use. The net amount of useful energy consumed in agricultural and craft production is low. In order to increase food, fibre and fuel production and to increase jobs, more energy in the forms of fertilizer, water lifting, seed and crop drying and mechanical power is required.

13. In fact, in many rural areas, there is, as noted, an ongoing "crisis" of destruction or deterioration of the resource base, owing to a cycle of interrelated action which often consists of population growth, increased fuelwood gathering and animal foraging, increased agricultural activity on marginal lands often previously forested, deforestation followed by extensive soil erosion, desert encroachment, loss of biomass productivity, reduced water retention capacity and increased flooding and increasing use of agricultural and animal residue as fuels, thus depleting the soil of recycled nutrients and conditioners and thus further reducing agricultural productivity.

14. While these problems have received increasing attention and are currently the focus of programmes being developed by both bilateral and international agencies, complexities such as those described above are rarely reflected in programme designs.

15. Another serious complexity poorly reflected in the literature on fuelwood and related issues are the multiple pressures on forest land and the problems of unequal distribution of resources among classes or groups and differential access to resources. With regard to the first problem, deforestation can result from permanent clearing of forest land for agriculture as well as from gathering fuelwood or from other over-use of forest resources. Too few studies have examined in detail both the food (and fodder) and the fuelwood/traditional fuel needs in particular areas to discriminate between these pressures. When studies include such issues and other complex interrelations they not only reinforce the view of traditional fuels as part of complex resource and social systems but they also suggest that solutions are not easy and that alternatives must be evaluated in the light of these complexities. Part of the complexity is the differential access to resources and the failure of aggregate - at the village level - measures to reflect problems particular to class or location.

16. Rural energy policies must take a holistic view of these complex systems and additional efforts must be made to increase our knowledge of the physical and social structure of these systems.

B. Current and possible future pattern of energy consumption

17. For most developing countries, few data are available on rural energy consumption patterns in the household sector (cooking, heating and lighting) and the agriculture, transport and rural industry sectors. However, as indicated in table 1 below, considerable data exist for specific cases. Many problems arise with regard to obtaining accurate estimates of non-commercial energy resources and the modest data so far available for rural areas in certain developing countries have serious short-comings related to the initial accuracy of the data, definition problems and the choice of conversion factors and units. Any estimates with respect to consumption patterns for non-commercial fuels in rural settlements should therefore be considered approximate and incomplete at best.

18. An analysis of existing data on the consumption of non-commercial fuels and of estimates for future consumption clearly highlights the seriousness of the

energy problem with regard to the maintenance of present substance-level patterns in rural settlements. Consumption in the rural domestic sector varies from 30 per cent to 70 per cent of total primary energy consumption in the agricultural, transport and rural industrial sectors. Estimates have been made of the share of traditional fields of the over-all national energy consumption in many developing countries. Openshaw /14/ 1/ estimated that between 40 and 50 per cent of the world's population relies on fuelwood and biomass for cooking and that fuelwood supplies about one fifth of the world's fuel requirements. Parikh /15/ estimated that commercial energy sources supply less than 10 per cent of total energy in such countries as Nepal, the United Republic of Tanzania and Mali. In central and northern Africa, approximately 35 per cent of total energy consumed is commercial, 10 per cent is agricultural residues and the remaining 55 per cent is fuelwood. In Bangladesh, these sources account for over 70 per cent of total consumption, though uncharacteristically fuelwood is less important than agricultural residues. In the absence of concerted efforts, the situation in Bangladesh may be indicative of what will evolve in other areas.

19. Table 2 /27/ indicates the share of fuelwood in total recorded energy consumption. In the world as a whole, fuelwood and wood for charcoal represent 59 per cent of the total volume of wood removed from the forest - 1,566 million m^3 out of some 3,050 million m^3 in 1978. Fuelwood is much more important in some regions and countries. In Africa, it contributes 58 per cent of total energy consumption. In some countries, it amounts to over 90 per cent of all energy supplies.

20. A survey of the evolving fuelwood situation has been undertaken by the Food and Agriculture Organization of the United Nations (FAO) through assessments of existing and potential fuelwood consumption and supply, independent of political or geographical boundaries. The survey provides a clear identification of where fuelwood shortages exist or are emerging under current trends. It indicates the magnitude of the population involved, the severity of the shortages and the physical potential for maintaining or improving fuelwood supplies. The main conclusions are summarized below; table 3 below presents the information on populations involved. /27/

21. Acute scarcity situations involved in 1980 approximately 90 million rural people in developing countries. Minimum energy needs are not met and energy consumption is below minimum levels. Such situations prevail in Africa mainly in the arid and subarid areas south of Sahara, in East and South-east Africa and in mountainous areas, in Asia in the Himalayas and the hills of South Asia and in Latin America, mostly in the Andean Plateau and the arid areas of the Pacific Coast in South America. In addition, some 150 million people live in major urban centres situated in rural areas already having a fuelwood deficit. Under prevailing ecological conditions and with expanding demographic growth, any large-scale forestry effort to improve the fuelwood supply is likely to be very costly and to offer only a partial solution to increasing energy needs.

1/ Numbers in brackets refer to entries in the list of references.

Table 1. Fuelwood and other traditional fuel use

Country	Source of estimate	Type of use	Fuel a/	Consumption	Wood equivalent (tons per capita per year)	Energy equivalent (gigajoules per capita per year)
Bangladesh	Briscoe Islam de Lucia and Tabors	Village Rural cooking	A		.4	5.7
Benin	Digernes	General	W	2.1-2.6 tons	2.1-2.6	29.4-36.4
Bolivia	Makhijani and Poole	Rural general	W	2 tons	2	28.0
Botswana	Thipe S. Makobi (secondary) b/	Water heating	W	.53-.7 tons	.53-.7	7.4-9.8
Brazil	Muthoo	General	A, C, W		.8	11.2
China	Smil Smil Makhijani and Poole	General General Rural general	A W		.23 .11 1.5	3.2 1.6 21.0
Fiji	Siwatibau and others	Villages				
Gambia	Floor, Arnold and Jongma	General	W	.9-1.1 tons	.9-1.1	12.6-15.0
India	Reddy Argal (secondary) Gosh (secondary)	Rural General Domestic	W A, W A, W, D	.6 tons	.6 .8 .6	8.4 11.2 8.4
Indonesia	Weatherly and Arnold Harahap and others	Rural cooking Rural cooking	W, A W		.5	7.0
Iran	Nyoike (secondary)	Village	W	1.2 tons	1.2	16.8
Kenya	Openshaw (79)	Cooking/ heating	W	.7 tons	.7	9.8
	Hughart/Meta	General General	W W	1-1.5 m^3 1.1 tons	.7-1.1 1.1	9.8-15.4 15.4
Mexico	Makhijani and Poole	Rural general	A, W		.9	12.6
Nepal	Asia Foundation Earl Bajracharya	Rural general General Village	W W	.73 tons 1 m^3, 43 tons	.73 .43-.73	10.2 6.0-10.3
Nigeria	Makhijani and Poole McComb and Jackson Ag	Rural General Urban	A, W W W, C	.27 tons	1.0 .27 .55	14.0 3.8 7.7
Pakistan	Government of Pakistan					
Papua New Guinea	Government of Papua New Guinea	Rural general	W	.4 tons	.4	5.6
Peru	Meta	Rural general	W	1.2 tons	1.2	16.8
Philippines	Manibog					
Sri Lanka	Bailey	Rural cooking	W	.43 tons	.43	6.0
South Africa						
Sudan	Arnold and Jongma Digernes	General Rural	W W, C	1.2 tons	1.2 3.2	16.8 44.8
United Republic of Tanzania	Openshaw (76, 79) Arnold and Jongma	General	W	1.5-1.7 tons	1.5	21.0
	United Republic of Tanzania, National Science Research Council	General	W, C		1.4	19.6
	Makhijani and Pools	Rural general	A, W		1.5	21.0

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Table 1 (continued)

Country	Source of estimate	Type of use	Fuel a/	Consumption	Wood equivalent (tons per capita per year)	Energy equivalent (gigajoules per capita per year)
Thailand	Openshaw (76) Arnold	General	W	1.4 m^3, 1.1 tons	1-1.1	14.0-15.0
	Openshaw (72) Jongma	Urban	W	.5	.5	7.0
Tunisia	Hanza	Rural general	W	1.2	1.2	16.8
Upper Volta	Floor	General	W	.5	.5	7.0
	Ernest	Rural cooking	A, W		.6-.8	8.4-11.0

Source: Russell J. deLucia, "Infrastructure for rural energy systems" (Cambridge, Mass., Meta Systems).

a/ A - agricultural residues; C - charcoal; W - wood; D - manure.

b/ Secondary indicates that author has not had access to actual source documents, only to another author's use of the figures and indication of the source.

Table 2. Fuelwood in world energy consumption, 1978

	Population (millions)	Fuelwood a/ total (million m^3)	Consumption per capita (m^3)	Energy equivalent of fuelwood b/ (million gigajoules)	Commercial energy c/	Fuelwood percentage of total d/ (percentage)
World	4 258	1 566	0.37	14 720	256 594	5.4
All developed	1 147	145	0.13	1 363	205 115	0.7
Market economies	775	54	0.07	508	145 148	0.3
Centrally planned economies	372	91	0.24	855	59 967	1.4
All developing	3 111	1 421	0.46	13 357	51 479	20.6
Africa	415	353	0.85	3 318	2 415	57.9
of which LDCs	138	163	1.18	1 532	255	85.7
Asia	2 347	796	0.34	7 478	37 558	16.6
of which LDCs	130	34	0.26	319	180	63.9
Centrally planned	1 010	220	0.22	2 068	24 048	7.9
Latin America	349	272	0.78	2 557	11 306	18.4
of which LDCs						

a/ Includes wood for charcoal.

b/ IM^3 equivalent to 9.4 gigajoules.

c/ IMT coal equivalent equals 29.3 gigajoules.

d/ Other sources of non-commercial energy important in some regions not included.

Table 3. Populations involved in fuelwood deficit situations a/

(Millions of people)

Region	1980						2000			
	Acute scarcity		Deficit		Prospective deficit		Acute scarcity		Deficit	
	Total	Rural	Total	Rural	Total	Rural	Total	Rural	Total	Rural
Africa	55	49	146	131	112	102	88	74	447	390
Near East and North Africa			104	69					268	158
Asia, Pacific	31	31	645	551	308	271	238	53	1 532	1 441
Latin America	15	9	104	82	158	99	30	13	523	236
Total	101	89	999	833	578	472	356	140	2 770	2 225

a/ Indicates the total population and the population with a predominantly rural type of energy consumption (total population less urban centres over 100,000 inhabitants); these are the estimated populations living in the areas under the identified fuelwood situations.

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22. Deficit situations in 1980 involve 833 million rural people and 166 million urban dwellers in areas where populations are still able to meet their minimum energy needs, but only by harvesting in excess of sustainable fuelwood supply. Populations in such situations in Africa amount to 146 million people, mainly in the savannah areas in West, Central and South-east Africa. In North Africa and the Middle East, 70 million rural people live in fuelwood deficit situations. In Asia, 550 million people in rural areas and small urban centres, mainly in the Indu Ganges plains of Central Asia and in South-East Asia, are affected. In Latin America, 82 million rural people live in such deficit situations, mostly in the semi-arid and arid areas.

23. Prospective deficit situations are those where the availability of supplies is in excess of demand in 1980, but where, if current trends of depletion of fuelwood resources continue, deficits will occur by year 2000. In the evolving situations, the additional population living under deficit conditions will amount to 1,000 million people, of which 800 million are rural. Over half of the additional populations in these situations will be in Asia; in the whole of Central and South Asia, fuelwood may be expected to play only a marginal role by the year 2000 if current trends continue.

24. By 2000, under current trends in a few countries (seven in Asia, six in Africa, nine in continental Latin America), there will still be adequate supplies because of the favourable availability of resources in relation to evolving populations.

C. Village energy requirements: alternatives to meet the needs

25. Within the rural village, all energy needs may be classified as one of the following basic requirements: heat, light, shaft power, other mechanical power, fertilizer and communication (implicit energy needs). The five basic requirements fulfil all of the village/household end-use energy needs shown in the figure below, ranging from cooking to plowing, grinding and transport. Improvements in supplying these five basic requirements for rural areas have tended to be classified as "new technologies", yet as shown in the figure, they are more logically grouped into three classifications depending upon the function that they are fulfilling. These three classifications are: energy source modification or augmentation; change/improvement in end-use device; and development of conversion technologies. In addition, there is the possibility of using additional conventional fossil-based sources.

26. Energy source modification or augmentation represents the development or utilization of a source of energy not currently available to the rural village environment or the modification of sources now in use. There are a number of examples of such changes. Wind power systems have not been available to many rural areas in developing countries and, as a result, wind as a source of energy represents a new or augmented source. The same may be said for many of the renewables, including small-scale hydro and solar systems. An augmented source would be the development of village woodlots and the planting of fast growing species.

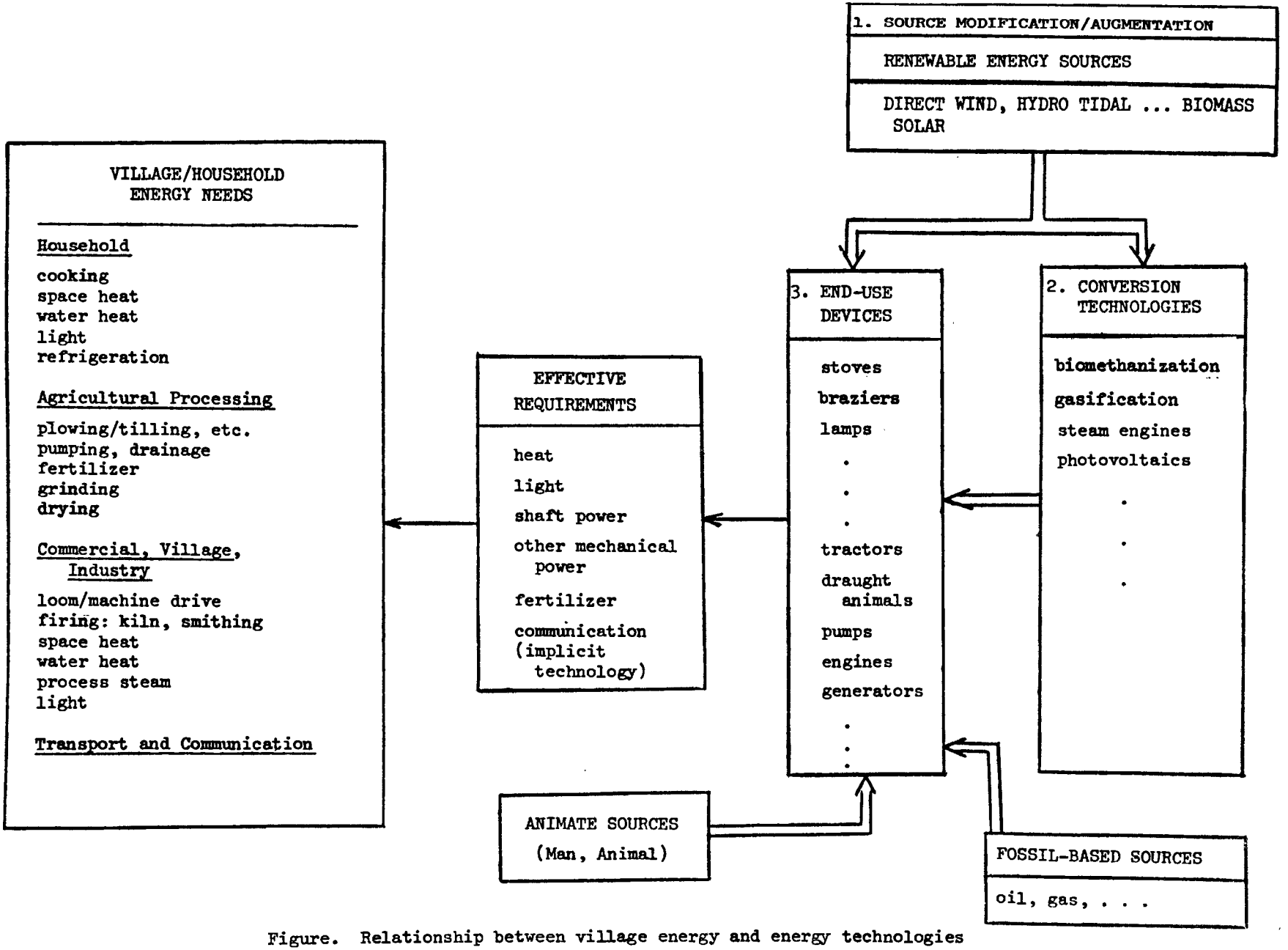

Figure. Relationship between village energy and energy technologies

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27. A number of new energy conversion technologies are currently in use and under development, utilizing the sources discussed above to produce the intermediate good, usable energy. Examples of conversion technologies range from biogas plants currently under intensive development in many areas of the developing world to the high technology options such as photovoltaics. Conversion technologies must be differentiated from the third category, end-use devices, where the objective of the development effort is the efficient use of energy. An important example is the development of more efficient stoves; another is the improvement of bullock carts.

28. Many of these technologies have been intensively reviewed by the various expert groups and technical panels as part of the preparation for the United Nations Conference on New and Renewable Sources of Energy. Although a detailed discussion is therefore unwarranted in this paper, some of these technologies are briefly discussed below. However, it should be noted that, in general, the appropriate energy source and technology that should be part of particular systems are site specific. Moreover, it is apparent that in many cases mixed systems using both renewable and conventional resources may be appropriate and that a complementary use of multiple renewable sources and technologies may in many situations best fit these complex systems.

29. While there are clearly some situations in which renewable sources such as hydropower or wind will be attractive, at this point in time at least one broad class of resource and technology appears to be attractive in many situations, such as technologies that are based on biomass and, if forest resources are managed, on wood in particular. Work recently undertaken for the Technical Panel on Fuelwood and Charcoal suggests that such alternatives are viable under a wide range of conditions.

III. UTILIZATION OF ENERGY IN AGRICULTURE

A. General considerations

30. Agriculture is a dominant factor in the energy systems of rural areas, both as the main economic activity using commercial and non-commercial energy, and as one of the suppliers of energy for rural households, industries and services, and for its own use.

31. Agricultural production uses only a very small proportion of the total amount of fossil fuel consumed. However, this small proportion is essential for the rapid increases in production required by a growing population. It is therefore important not only that agriculture should be assured the quantities of fossil fuel energy that it requires, but also that it should contribute to its more efficient and economical use.

32. In the long run, non-renewable sources of energy will be supplemented by renewable sources. Here the agricultural sector can itself make a contribution, for in addition to being a user, it is also a producer of energy. It produces not only the dietary energy derived from food but also fuel in the more conventional sense. A great deal of attention is currently being given to the possibility of growing crops specifically for the purpose of providing fuel. Of much more widespread importance, however, is the fuel derived from wood and from crop and animal residues. These play so large a part in the fuel supplies of the rural areas of the developing countries that it is essential to look at agriculture in the wider context of rural energy systems.

B. More efficient energy use in agriculture

33. In agricultural production itself, there are a number of ways in which chemical fertilizers can be used more efficiently through improved agricultural practices and the improved application of fertilizers. Some of these improved methods are labour intensive, and thus suit the rural employment situation in most developing countries.

34. As regards farm machinery, some of the minimum tillage systems and practices show great savings in fuel. The need for insecticides and fungicides can be reduced by developing new methods based on the principle of integrated pest control, which relies mainly on natural elements, including biological control and pest-resistant varieties of crops.

35. Methods of saving fuel in industrial and semi-industrial fisheries (where it accounts for 25-30 per cent of operating costs) include the development of effective sail rigs for small boats and of energy-saving fishing gear, and the replacement of petrol outboard motors by low-powered diesel engines. In agricultural processing industries there is a wide scope for saving commercial energy by introducing more efficient burners and insulation and by recycling waste heat. In addition, more attention needs to be given to the introduction of low energy processing methods such as smoking, salting, pickling and fermentation.

Rises in the relative cost of transport as a result of fuel prices will increasingly affect the location and capacity of processing plants and marketing facilities.

C. Energy substitution in agriculture

36. In addition to seeking greater efficiency in the use of fossil fuel, it is necessary to substitute renewable resources for such non-renewable ones or at least to use them as supplements. Often it may be necessary to change entire farming systems in order to provide a suitable framework for energy substitution. This involves a difficult task, not only for researchers but also for extension services.

37. Chemical fertilizers can be partly replaced by the greater use of such practices for maintaining soil fertility as crop rotation, cash cropping, ley farming with a legume rotation and the recycling of crop and livestock residues. Difficulties involved in the greater use of crop and livestock residues as organic fertilizers may include the need for changes in farming systems and in the orientation of extension services, transport problems and the fact that in some developing countries much of the more accessible material is used for fuel. There is also much scope for making fuller use of the existing nitrogen fixation capacity of legumes, blue-green algae found in paddy fields and the like.

38. More attention should be paid to animal draught power and to the improvement of animal draught equipment and hand implements. Since large areas of land are required to feed draught animals even when they are not working, their use is limited where land is in short supply, unless crop yields are very high. They themselves, however, contribute to the necessary intensification of production and raising of yields.

39. The use of animal manure/fuel is widespread in Asia and parts of Africa. Animal manure is also useful as fertilizer, and its fertilizer value is largely destroyed if it is burned. This problem is overcome if it is used to produce commercial energy by anaerobic digestion, since this yields methane (biogas and carbon dioxide) as a fuel while the plant nutrient value of the residue remains.

40. Non-commercial energy production from crop residues is estimated as only about 7 million tons of oil equivalent a year but the potential energy content of exploitable crop residues is very much greater.

41. Food processing by-products are another source of biomass for energy production. The biggest potential sources are bagasse from cane sugar extraction (estimated at 24 million tons of oil equivalent a year) and rice hulls from milling (18 million tons).

D. Energy cropping versus food

42. The uncertain policy area concerns the use of biomass, and in particular of agricultural crops produced specifically for the purpose, to provide liquid

fuels to replace those derived from fossil fuels. In the longer run, the production of alcohol from wood and from crop residues, which would not compete with food crops, could become an important source of liquid fuel. High priority should be given to perfecting the necessary conversion technologies as quickly as possible. Energy cropping based on food crops might then prove to be no more than a temporary expedient. In the meantime, policies encouraging energy cropping should be pursued with great caution and flexibility, bearing in mind that they may have serious repercussions on food supplies and prices.

IV. A NOTE ON COSTS

43. Fuelwood potential is frequently cited as a single number without reference to the inputs (broadly speaking, the price) available for its production, even though it is common knowledge that plantations produce more than do natural stands with little care, and plantations with more inputs can yield more than those with less. The price of wood is clearly going up. The question is what supply response, especially sustainable supply, can be expected? That is, what is the shape of the supply curve - is it elastic or inelastic?

44. In general, costs range from $0.60 to $1.00 per gigajoule (in 1978) for fuelwood that is ready to harvest. This is more expensive than the "free wood" formerly cut and, in this context, can be a source of hardship. On the other hand, in relation to other alternative fuel sources, it is not high (crude oil is now more than $5.00 per gigajoule), which suggests the possibility that strong expansion of this resource may be economic. Cash outlays for programmes to plant wood for subsistence uses (where labour costs are not included) may be much lower, of the order of $0.10 to $0.15 per gigajoule produced. To test the economics of supplying specific end-uses (cooking, industrial process heat, shaft power in industry and agriculture), it is necessary to estimate in addition the harvesting and transport costs and the relative capital and operating costs of conversion equipment using fuelwood and alternatives (especially oil).

45. There has been a tendency in the literature to pay greater attention to plantation establishment and maintenance costs than to harvesting and transport costs. The more aggregated estimates for the latter show a greater range and there is an urgent need for more analysis. Preliminary evidence suggests that a harvesting cost of $.35 per gigajoule is reasonable. A minimum cost of transport of $.004/GJ-km is suggested for charcoal and $.008/GJ-km for fuelwood. The actual cost is likely to be somewhat higher.

46. In order to evaluate conversion systems, fuelwood prices of $2.00 and $4.00 per gigajoule were used. With the lower assumption ($2.00 per gigajoule - which is likely to be representative of locally delivered plantation wood), preliminary results suggest that for shaft power, gasifier/diesel combinations in the 20-100 horsepower range are cost effective (without shadow pricing) compared to diesel.

47. Gasifier/gasoline engines may also be cost effective in the 5-10 horsepower range as compared to gasoline engines alone. For steam generation, direct

combustion of wood at $2.00 per gigajoule appeared to be competitive with fuel oil at $5.00 per gigajoule in the 30-300,000 lb/hr steam production range. Steam/electric generation, however, appear to compare considerable less favourably.

48. For cooking, wood at $2.00 per gigajoule cost approximately the same as kerosene at $6.50 per gigajoule. The wood estimate assumes careful operation of an unimproved wood stove (this can increase efficiency by 20 per cent). In rural areas, however, even planted wood is likely to cost much less than $2.00 per gigajoule in terms of cash outlay.

V. COMMENTS ON TECHNICAL FACTORS CONCERNING NEW AND RENEWABLE SOURCES OF ENERGY

49. The traditional way of using renewable energy sources mainly involves biomass, of which fuelwood is dominant. New, more direct energy conversion systems can have higher efficiencies. However, energy efficiency is not the main consideration for the user of renewable energy sources. Cost effectiveness is decisive, no matter how the cost is expressed - in terms of money or human cost. It must therefore be stressed that systems with moderate performance can be cost-effective if they are simple and cheap enough. With renewable resources, sophistication is not at all a guarantee for socio-economic performance.

50. Selecting technologies for rural energy is not a simple task but a complex problem, even when limited to its technical parameters. One has to determine an optimum combination of technologies to meet different end-use demands from different available sources, within the limits of local socio-economic constraints.

51. The following end-uses can typically be distinguished: electricity (light, telecommunications and the like); mechanical work, fixed or mobile (milling, pumping and so on); high, medium or low temperature heat (for example, forging, grilling, cooking, drying); chemicals (fertilizer); food.

52. Renewable sources of energy might be solar radiation (a low density input, less less than 1 Kw/m^2), wind (a mechanical, intermittent phenomenon), hydropower (mechanical) or biomass (a mechanical, storable and transportable fuel).

53. Owing to socio-economic constraints, any solution will be location-specific. However, some general facts can be stressed.

54. In most cases, reducing energy consumption is more cost-effective than increasing the supplies. For example, reduction of fuelwood consumption by means of improved woodstoves, or complement of reforestation, is most cost-effective.

55. In general, a shorter energy conversion path performs better. For example, a water-pumping windmill (if wind is available) is more effective than a solar pump. On the other hand, low-level heat from solar energy (for drying, for example) is an easy one-step natural process, whereas power generation from the sun by a thermal cycle is a sophisticated, low-efficiency operation.

VI. MAJOR CONSTRAINTS AND PROBLEMS

56. There are a multiplicity of problems and constraints associated with the development, supply and utilization of new and renewable sources of energy in the rural areas. These include, inter alia:

(a) Unavailability of policies and strategies for the development and use of new energy technologies and systems in rural areas;

(b) Infrastructural issues in rural areas, such as transport, storage, maintenance (both labour and parts);

(c) Institutions; skilled manpower to manage and operate the systems; access to funds;

(d) Terms for loans and investments in rural areas;

(e) Affordable cost to the consumer and productive enterprise;

(f) Inadequate research, development and demonstration of new technologies and systems;

(g) Available information on the kind of data required, resource base and proven technologies and systems.

57. There are also such other factors as:

(a) Poverty, remoteness and dispersed patterns of rural settlements;

(b) Difficulties in achieving technical and other changes in rural areas;

(c) Lack of political will in identifying and solving the problem.

58. Many of these issues are discussed at length in the section below on recommendations.

59. Suffice it to say, in resolving the problems and overcoming the constraints, the following must be borne in mind:

(a) Effective development and management of rural energy use and production can be best achieved within the framework of rural energy systems. This calls for a better understanding of the energy flows in local rural economic and social units, such as villages or small market towns and their environs. It also calls for those who deal with the individual components of the system to take into consideration the totality of inter-relationships when proposing changes.

(b) While most rural energy technologies have reached sufficient maturity, additional effort is required to optimize their performance.

(c) There are certain inadequacies and drawbacks in the use of new energy technologies in rural areas; these become more serious with increases in complexity and intensity of use.

(d) There is a need to further elaborate the integrated rural energy concept. It looks at the farm and the rural community as an energy system capable of producing its own energy requirements to meet total related energy demand through time and in terms of quality of energy required, by appropriately mixing or combining renewable and conventional feedstocks and technologies.

60. The concept of an integrated rural energy system is obviously not new. But comprehensive research and development, which would start from the logic of the concept and work out the implications of a complete system, including its operational aspects, by means of testing and demonstration activities, is practically non-existent.

61. In a wider perspective, energy planning for rural areas must be integrated with over-all agricultural planning. The first step in this direction will be the further development of methodologies for the analysis and management of rural energy systems. These will have to provide links to both agricultural development planning and to national energy planning. They will also have to be tested in practical planning situations and their widespread implementation ensured by training people in their use.

VII. RECOMMENDATIONS

62. The PRINCIPAL RECOMMENDATION of the Ad Hoc Expert Group is that national Governments, the United Nations system, and other regional and international agencies should commit themselves to strengthening the position of rural people in their access to sufficient supplies of energy given the current circumstances of increased competition for scarce supplies of useful energy. This is necessary both to prevent the further deterioration of the currently inadequate levels of rural subsistence and to allow genuine rural development in future.

63. This recommendation is based on the view that:

(a) Although rural people constitute the majority of the world's population, they have traditionally been disadvantaged;

(b) Rural people are nearest to the margins of subsistence and consequently their adjustment to increasing energy scarcities will be particularly painful; furthermore much of the burden of this adjustment is likely to fall on women and children;

(c) Adequate access to energy for rural development, and in particular for cooking and heating, is of basic importance to survival; adequate supplies of energy are also fundamental in ensuring food security for both rural and urban populations;

(d) Growing demand for traditional fuels and food has accelerated the process of excessive deforestation and threatens the environmental stability of large areas of developing countries.

64. However, the Group recognizes that there are formidable constraints to implementing such a recommendation. These include:

(a) The poverty, remoteness and dispersed pattern of settlement of rural people;

(b) The increasing debt burden of developing countries and the world-wide recession;

(c) Political and social forces that result in the concentration of resources in urban areas and in industrialized countries;

(d) The competition for non-renewable energy resources in world markets, particularly from industrialized countries, and the fact that so far the attempts of industrialized countries to reduce their consumption of oil-based energy resources have proven inadequate;

(e) Lack of awareness on the part of many Governments and people regarding the nature of rural energy needs and the possibilities of meeting those needs;

(f) The complex problems encountered in almost all previous attempts to achieve technical and other changes in rural areas (such as those associated with the introduction of new agricultural practices, rural water supplies, basic health services and other elements of rural development);

(g) The difficulties experienced in securing the active participation of all sectors of rural society in the specification of problems and the design and implementation of solutions; and

(h) The difficulty of dealing with rural energy matters because they fall between the traditional areas of responsibility handled by ministries, institutions, professional groups and academic disciplines.

65. The Ad Hoc Expert Group recognized that no easy or universal solutions to rural energy problems were likely to emerge. The viability of those solutions that do exist are likely to be location specific. Fuelwood and agricultural residues will remain the major source of inanimate energy for the mass of rural people at least until the year 2000. Of equal importance is the supply of energy from both conventional and renewable sources of energy to sustain and increase food and agricultural production. But in the light of these constraints, the Group recommends six major areas for action, which are discussed below.

A. Policy, planning and political commitment

66. Action: Develop and sustain rural energy policies and programmes for the provision of adequate supplies of energy for rural development programmes.

67. If the energy needs of the rural sector are to be met, massive concerted action is urgently required within carefully planned strategies; action is required not only to increase and organize the supply of fuels and to improve their efficiency in conversion and use but also to manage and monitor the demand in rural areas. Rural energy strategies should be carefully developed as an integral part of national energy and rural development policies and programmes. The aim is to ensure that the rural sector has adequate and equitable access to both renewable and non-renewable sources of energy which are indispensable for the subsistence of all socio-economic groups.

68. The main objectives are:

(a) To ensure adequate energy supplies at reasonable prices for domestic use, for agriculture and for rural industry;

(b) To guarantee to the rural sector adequate supplies of conventional and non-renewable sources of energy to sustain rural development during the transition period until dependence on non-renewable sources of energy is reduced by proven technologies for conversion and the use of renewables;

(c) To combine economically efficient fossil and renewable energy sources into systems that meet the needs and capabilities of specific groups of rural people;

(d) To encourage the transition to the greater and more efficient use of locally available renewable sources of energy through decentralized and environmentally, socially and economically sound integrated rural energy systems;

(e) To undertake massive and sustained action-oriented fuelwood programmes as an integral part of rural energy and development programmes;

(f) To stimulate local participation and co-responsibility in the identification of rural energy needs and in the design development, adaptation, implementation, evaluation and management of rural energy systems;

(g) To implement actions that have both short-term and long-term effects, reflecting the evolving nature of the rural energy situation and the need for urgent measures;

(h) To regulate energy prices with due concern for equity between social groups and absolute poverty, the relative competitiveness of alternative new and renewable sources of energy, and the prices of other commodities which the rural areas buy and sell to the urban and industrial sectors;

(i) To consider the social and economic consequences of competition for land and other resources in the production of food and fuel. In particular, efforts should be made to prevent the development of new and renewable sources of energy from worsening the distribution of income, or the ecological balance.

Responsibility and methods

69. These actions are the responsibility of national Governments which should raise the general awareness and commitment of all concerned - both institutions and people.

70. International and regional organizations should review their current practices in order to reinforce their assistance capability in line with the scale of action required and should devote particular attention to strong supporting efforts in developing countries for technical assistance and the building and strengthening of institutions particularly in the fields of planning, project formulation, implementation and evaluation of energy programmes and projects.

B. Institutions

71. Action: Strengthen existing institutions, or creating such institutions where necessary, for the identification of rural energy development needs and the design, selection and implementation of rural energy programmes.

72. If rural energy is to be developed adequately it should be the responsibility of institutions with sufficient influence to integrate actions relating to rural energy with other energy activities in the urban and industrial sectors and with rural development.

Responsibilities and methods

73. At the national level the necessary action would involve the strengthening (or creation, if necessary) of institutions at all levels under the co-ordination of the relevant ministry. These institutions should be responsible for the co-ordination of energy programmes, the operation and maintenance of facilities, research and development, training, extension and credit. In many countries the capabilities of the non-governmental organizations and the private sector should be utilized where possible. Local participation should be strongly encouraged in the operation of these institutions. Participation in the operation of rural energy programmes should be particularly encouraged.

74. Basic to the effective implementation of a national rural energy policy are the following considerations:

(a) At the central government level a ministerial (or national) organization should take responsibility for evolving an effective national energy policy, for supervising the preparation of national and rural energy plans and for co-ordinating their implementation.

(b) Training activities should, to the extent possible, be the responsibility of existing training and educational institutions. Supervision of these training programmes in rural energy should be the joint responsibility of the ministries of education and other relevant agencies. A major emphasis must

be the training of village-level workers in new and renewable energy resources and technologies related to production, conversion, conservation and utilization.

(c) Another important dimension of training involves the training of energy technicians (to train village-level workers) and specialists.

(d) A third aspect of training is the conduct of seminars, symposia and the like on energy issues in order to create awareness of the dimension of the rural energy situation and its relation to broader socio-economic objectives and feasible approaches to ameliorate these problems.

(e) Programmes at national research institutes should be strengthened or expanded to address energy-related research tasks. In the field of renewable energy, national research efforts in biomass production, conversion and utilization will be particularly important.

(f) Rural technology centres or workshops should be strengthened, and where necessary established, to fabricate, test, maintain and repair rural energy devices and agricultural implements, including such rural transportation machinery as ox carts.

At the international level action would include developing the capability to meet the requests of national Governments for assistance. In particular, the international agencies should increase the capacity of developing countries to develop and implement comprehensive rural energy programmes; encourage and strengthen international, regional and interregional co-operation in research and development in new and renewable energy sources through the exchange of literature, visits, symposia and joint research and development projects. In these activities the international agencies should further strengthen their co-ordination procedures to prevent duplication of effort.

C. Finance

75. Action: Commit a considerably increased level of financial resources which reflects the urgency and scale of the rural energy problem.

76. The global levels of funding required to adequately develop rural energy use is not currently known. The Ad Hoc Expert Group notes the recommendation of the Technical Panel on Fuelwood and Charcoal that to meet basic fuelwood requirements by the year 2000 will require an expenditure in excess of $1,000 million per year; such a figure does not include the cost of the necessary institutional infrastructure. Although fuelwood will continue to be the fuel of necessity for the majority of rural populations, the development of an optimal mix of energy sources will inevitably cost considerably more than this.

77. Direct investment will be required to develop and introduce new energy-conversion technologies. In addition, funds will be required to shift the pattern of energy end-uses, such as changes to less energy-intensive production systems, and retrofitting of energy-saving devices in rural industries.

Responsibilities and methods

78. At the national level increased levels of funding to meet energy needs would be ear-marked for the rural sector. Financial institutions and procedures would have to be adapted to increase access to financial resources for all socio-economic groups under terms that are appropriate to the circumstances of the recipient and the specific nature of the energy-related activities.

79. Prices, taxes and subsidies should be reviewed to remove those elements that favour inequities in the use of scarce energy resources and promote the continued use of non-renewable energy sources. Temporary subsidies and other incentives may be required to assist the introduction of new energy technologies, although Governments should take account of the true scarcity value of internationally traded commercial fuel.

80. International agencies would take further steps to develop emergency funding mechanisms which meet the particular problems of countries with acute rural energy shortages in order to ensure their access to the required energy supplies for subsistence and development. Action will be required at the international level to finance those countries already heavily in debt to the world financial system in order to permit their transformation to economies that are less dependent on fossil-based sources of energy.

81. In evaluating rural energy projects international agencies should consider not only financial returns but also the returns to broader social, economic and environmental objectives. For example, account could be taken of the employment that might be generated through the fabrication, installation and maintenance of the devices associated with small-scale energy-producing and conserving technologies. Such additional employment may have considerable positive implications for income distribution.

82. If and when the financial resources are made available through institutions such as the proposed international fund for energy development, a significant proportion should be ear-marked for rural energy, including new and renewable sources.

83. It is recommended that bilateral regional and international aid agencies should:

(a) Strengthen their programmes of financial assistance and technical co-operation in the field of non-conventional energy-generating and energy-using technologies for application in the rural areas of developing countries;

(b) Establish a public exchange of information on these activities to promote compatibility between programmes, such a mechanism to be instituted within one year of the conclusion of the Conference;

(c) Be increasingly prepared to finance rural energy projects with a high element of local costs (which may be especially important relative to other projects).

84. It is further recommended that paragraph 12 of General Assembly resolution 34/190 of 18 December 1979, on United Nations assistance to developing countries on new and renewable sources of energy, should be extended beyond the Conference.

D. Knowledge and skills

85. Action: In conjunction with the action programmes, a greater understanding and mastery of skills must be obtained on:

(a) Rural energy needs and their relationship to rural development;

(b) The extent and local potential of new and renewable sources of energy; and

(c) Technologies for converting and using new and renewable sources of energy.

86. The Ad Hoc Expert Group is of the opinion that the lack of political will has been a greater constraint to undertaking rural energy programmes than has the lack of knowledge; sufficient knowledge exists to initiate programmes of rural energy development, but it is recommended that ongoing research should be conducted to permit the design of better policy and improvements in implementation and evaluation. In particular, the following should be considered:

(a) Thorough studies should be made concerning the nature of the interrelationships and complexities of the physical, social, economic and institutional structures associated with the technical supply and use of largely non-monetized energy in the rural sector - for example, the division of labour at the household level in the utilization of energy. There is a need to extend a detailed understanding of the current situation in a range of locations in order to determine the likely future position as the basis of future action.

(b) While the nature of the many technologies likely to satisfy rural energy needs in the next 20 years are already largely known, detailed evaluations of these technologies and their potential for combination in integrated systems are required in order to determine their viability and relevance to particular socio-economic and physical environments, using rigorous methods which allow effective comparison.

(c) Additional applied and basic research must be undertaken to establish the extent, regeneration and rates of use of new and renewable sources of energy for the rural sector in order to identify areas with critical shortages of energy or areas where the ecological balance is threatened.

(d) Specific rural energy situations in which serious imbalances between supplies and needs of energy will result in energy scarcity should be identified and monitored.

(e) The possibilities for the utilization of new and renewable energy sources will depend on advances in physical, biological and other technical

research. In the short term, this is most likely to mean the adaptation of technologies to local situations; only in the longer term will more fundamental research show results. This research and development effort should give particular consideration to rural needs and conditions, should involve genuine field evaluation and should be firmly linked to extension services.

(f) In the planning and location of research it will be important to distinguish between those elements which are location specific and may require multidisciplinary research and those which are basic and universal;

(g) Available knowledge and experience should be exchanged more effectively.

Responsibilities and methods

87. As much of the knowledge required is highly specific to rural locations, the surveys of energy-use requirements and the endowment of new and renewable resources, as well as the field tests of technological devices, will necessarily be most effectively carried out by national and local institutions and will involve rural people, particularly women. National Governments would co-ordinate these studies, provide access to the results through a focal point and disseminate the results.

88. National Governments must expand their capability to undertake such work and, where necessary, create the necessary facilities and capabilities. To evaluate and implement the use of a combination of new and renewable sources of energy, national Governments must establish a number of detailed village studies to determine more fully the nature of the interactions between social, economic, physical and institutional factors and rural energy systems.

89. National Governments would organize the systematic collection of information and monitor the availability of new and renewable energy sources for the supply of energy in rural areas. Special emphasis should be attached to the integration of energy potential in current natural resources assessment programmes; specific surveys of new and renewable resources and potential for energy; and the identification of the available land suitable for biomass production, with due consideration to other competing land uses.

90. The international agencies have a useful contribution to make in those aspects of research which are not location specific; in particular, the international agricultural research centres may wish to consider supporting energy-related research which is complementary to their existing work.

91. International agencies would rationalize and strengthen existing networks for the collection, analysis and dissemination of relevant information and experience, creating new networks where appropriate. They must draw up methodologies for studies that would facilitate the comparison of legitimate results. They would identify and solve those technical problems which are not location specific. They should actively discourage the dissemination of unsubstantiated or self-interested claims for particular devices.

E. Training

92. Action: Intensify or organize the training of required technical staff in the various fields of renewable energy sources, technologies and systems suitable to rural areas; training of technicians should be organized in line with the urgency and scale of action required for rural energy.

93. A shortage of technical staff is usually one of the main limiting factors in rural energy programmes in developing countries. The intensification of existing training programmes and the organization of such programmes on an adequate scale is therefore essential to the success of action programmes, not only current programmes but also any major future policy and programmes on rural energy. The Expert Group noted in particular the view of the Technical Panel on Fuelwood and Charcoal that because of the particular importance of this source of energy, training programmes for forestry technicians and extension staff should be increased five-fold to seven-fold, according to the situation of the particular country and the size of the fuelwood programme. For other sources of energy, training can be integrated into related disciplines or be the subject of special programmes. Training in communication and the social sciences is essential for stimulating social participation.

Responsibilities and methods

94. Energy-related subjects should be included in existing technical-level training curricula and when appropriate should be presented in specialized courses. The number of technicians to be trained should be carefully adjusted to the needs of rural energy programmes, with due consideration to the time factor.

95. International organizations should promote and support, both technically and financially, national, regional and interregional training programmes related to all aspects of the organization, management, research and use of renewable energy sources in the rural sector.

F. Extension

96. Action: Organize or expand and intensify the extension capability of rural energy systems and technologies within the appropriate extension services of forestry, agriculture and other institutions involved in rural development; raise rural people's awareness and stimulate their capability to organize, manage and efficiently use their renewable energy resources.

97. The awareness and capability of rural people to operate and manage their renewable energy supplies within the framework of their specific situation and on a systematic basis are essential to the implementation of effective solutions to the rural energy problem. Extension services therefore have an important role

to play which should be based on a full understanding of the social structure and perceived needs and preferences of the rural people and of adapted proven technologies. The objective should be to promote and demonstrate the suitability of proven renewable energy-based technologies and systems in typical rural situations and to provide adequate technical support to rural areas at the community, farmer and household levels. Pilot demonstration projects would be necessary to accomplish this objective. Motivating, facilitating and stimulating the permanent participation of rural people in local solutions to their energy needs is basic to long-lasting action. Two-way communications is a continuing need in achieving participation from rural people.

Responsibilities and methods

98. Governments and institutions involved in agriculture and rural development should organize or intensify systematic training on the application of renewable energy in rural areas, either as part of extension training or of in-service training for existing extension staff. They should also increase substantially the number of new extension staff as a basic supporting element of rural energy programmes.

99. International agencies should particularly support national and local programmes for training rural extension staff in energy matters through appropriate technical assistance and funding. Furthermore, they should maintain, as an ongoing objective, the improvement of national technical competence to carry out training courses and demonstration projects.

Annex I

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Annex II

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